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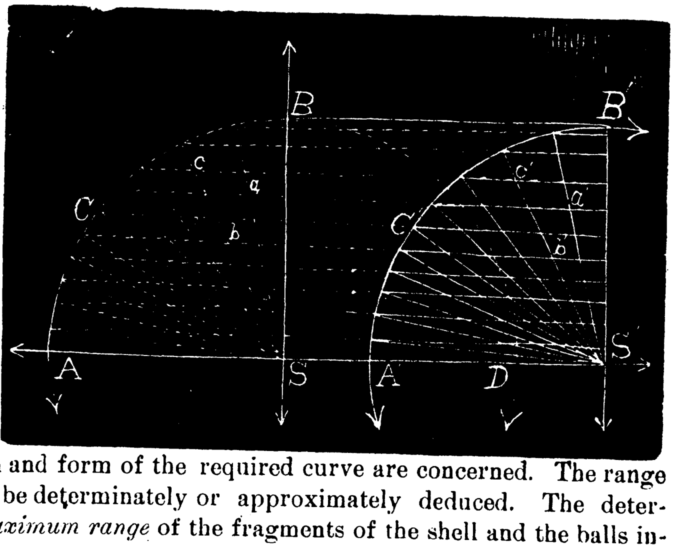
The equation of a system of confocal conics, foci at $(\pm c, 0)$, is $\dfrac{x^2}{a^2}+\dfrac{y^2}{a^2-c^2}=1\ldots.(1)$, a being the arbitrary constant. Differentiating, and putting p for dy/dx, $\dfrac{x}{a^2}+\dfrac{yp}{a^2-c^2}=0$, or $a^2(x+yp)=c^2x\ldots.(2)$. Eliminating a between (1) and (2), $\dfrac{x(x+yp)}{c^2}-\dfrac{y(x+yp)}{c^2p}=1$, or $xyp^2+(x^2-y^2-c^2)p-xy=0$ $\ldots.(3)$, which is the differential equation of the system. Putting $p=-\dfrac{1}{p'}$, we have $xyp'^2+(x^2-y^2-c^2)p'-xy=0\ldots.(4)$, which is the equation of the trajectory when $p'=dy/dx$, and it is identical with equation (3). In other words, the roots of equation (3), as a quadratic for p, are negative reciprocals.

Also solved by *Professors MATZ and ZERR.*

19. Proposed by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

A spherical shrapnel-shell is moving in a horizontal direction, with a constant velocity $V_1=1500$ feet per second. The shell explodes at a height $h=\frac{1}{2}g$; and the fragments of the shell and the balls inclosed by the shell, are *equably* scattered with a uniform velocity $V_2=1200$ feet per second. Draw the curve bounding *the minimum surface on the earth* on which the fragments of the shell and the balls inclosed by the shell, have fallen.

Solution by the PROPOSER.



The path of the shell is an inverted catenary of equal (or uniform) strength. At the point of maximum altitude of the path, $h=\frac{1}{2}g$, the shell moves in a horizontal direction. Ignore all such *complicating factors* as the resistance of the atmosphere, the rotary motion and geodesic contour of the earth, etc., as practically nugatory in so far as the position and form of the required curve are concerned. The range of the shell can now be determinately or approximately deduced. The determination of the *maximum range* of the fragments of the shell and the balls inclosed by the shell, is the next step preliminary to the drawing of the required curve. In the problem under consideration, the position of the shell at the instant of explosion is at some (unrepresented) point P vertically above S and perpendicular to the plane of the circle whose center is at S; that is $PS=h=\frac{1}{2}g$ $=16\frac{1}{12}$ feet. The fragments a, b, c, resulting from the explosion of the shell.

fall on the earth at a', b', c'. The required curve, therefore, is a circle, as it should be; and the radius of this circle is the maximum range of the *fragments* and *balls*. Of course, if the atmospheric resistance and other complicating factors be not ignored, it is reasonable that the required curve should be somewhat *oval-shaped*—thus, to a certain extent, resembling the apparent disc of the rising sun or of the rising full moon.

20. **Proposed by SAMUEL HART WRIGHT, M. D., M. A., Ph. D., Penn Yan, Yates County, New York.**

When does the Dog-Star and the Sun *rise together* in latitude $\lambda=+42^\circ\ 30'$, if the Right Ascension of the said star be $\alpha=6$ hrs., 40 min., 30 sec., and the declination $\delta=-16^\circ\ 33'\ 56''$?

Solution by F. P. MATZ, M. Sc., Ph. D., Professor of Mathematics and Astronomy in New Windsor College, New Windsor, Maryland.

In order that "The Dog Star" and the Sun may rise together, their *hour-angles at the instant of rising* must be the same. According to *Chauvenet's Spherical and Practical Astronomy*, Vol. I., p. 218, Art. 153, we have the formula:

$$t=\pm[-\tan\lambda\tan\delta],=74^\circ\ 10'\ 57''.77,=4h.\ 56m.\ 43.851\ sec.$$

Therefore, the next two *critical dates;* that is, the next two dates on which the *cosmical rising* of "The Dog Star" is possible in latitude $\lambda=+42^\circ\ 30'$, must be May 2, 1895, and August 2, 1895. By the Right Ascension of "The Dog-Star," as given in the problem, we are led to consider August 2, 1895, as the required date.

NOTE—The next two critical dates with respect to the *cosmical setting* of "The Dog-Star," evidently, are May 9, 1895, and August 11, 1895; and of these dates, the required one is May 9, 1895.

Also solved by *Professor ZERR* and the *PROPOSER*.

NOTE—No one of our contributors has as yet been able to effect a full and satisfactory solution to problem 21.

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OUTLINE OF INVESTIGATION FOR ASYMPTOTES.

(Continued from page 185.)

In $Y=y-x\frac{dy}{dx}$, sub. value of $\frac{dy}{dx}$, gives

$$Y=\frac{4ay^2-5xy^2-3x^3}{4ay-2xy}=\frac{4a-5x-\frac{3x^3}{y}}{\frac{4a}{y}-\frac{2x}{y}}=\frac{4a-5x}{0}=\frac{q}{0}=\infty,$$

since $y=\infty$ at limit.

Then by(c) under B, sub. values of X and Y, in $\frac{x}{a}+\frac{y}{b}=1$, gives $\frac{x}{2a}+\frac{y}{\infty}=1$. $\therefore\ \frac{x}{2a}+0=1$. $\therefore\ x=2a$ which is the equation sought.